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Development and preliminary examination of the predictive validity of the Falls Risk Assessment Tool (FRAT) for use in primary care

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Abstract

Background There is no validated assessment of an older person's risk of falling that is easily applied in primary care. We aimed to develop a two-part tool for use in primary care or the community. Part 1 includes a rapid assessment of the individual's risk of falling for administration by clinical or non-clinical staff. Part 2 (for clinical staff) includes guidance on further assessment, referral and interventions. We assessed the predictive validity of part 1.

Methods The tool was developed by an expert panel following the updating of an existing systematic review of community-based prospective studies identifying risk factors for falling and modified in accordance with the feedback from extensive piloting. We assessed predictive validity by a questionnaire survey sent at baseline and 6 months to a random sample of 1000 people aged over 65 in one Primary Care Group area.

Results Five items were included in part 1: history of any fall in the previous year, four or more prescribed medications, diagnosis of stroke or Parkinson's disease, reported problems with balance, inability to rise from a chair without using arms. The presence of three or more risk factors had a positive predictive value for a fall in the next 6 months of 0.57 (95 per cent confidence interval 0.43–0.69). Less than three risk factors had a negative predictive value of 0.86 (0.82–0.89), and a specificity of 0.92 (0.88–0.94).

Conclusion The tool may be useful for identifying people who would benefit from further assessment of their risk of falling and appropriate intervention.

Keywords: falls, older people, risk assessment

Introduction

Falls in older people are common. The consequences of falls include fear of falling, fracture and death. Falls are costly in terms of both individual suffering and health service utilization. Two sets of guidelines for the prevention of falls in older people published in 2000 and 2001[1,2] recommend that interventions should be targeted at high-risk groups. However, there is no easily applied and validated tool to assess risk of falling among older people in the community. The tools, scales and instruments included in a review by Perell and colleagues[3] are valid for hospital in-patient and out-patient populations, but many are not practical for screening in primary care.

As part of a pilot study to test a multi-agency model of falls prevention[4] we developed an assessment of falls risk for older people outside hospital that could be used by health or social care workers. The tool had two parts: part 1 for identification of those at higher risk of falling and part 2 for guidance with regard to further assessment, referral options and intervention for those identified as high risk.

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Methods

Development of the Fall Risk Assessment Tool

Previous reviews[5,6] of studies identifying risk factors for falls among elderly persons living in the community found four observational studies[7–10] of good methodological quality. We updated the review of Stalenhoef *et al.*[5] with studies published between 1994 and 2000 that met the following inclusion criteria: original investigations of falls in older people living in the community and falls or falls-related injury as an outcome. A MEDLINE search was conducted using the same keywords: accidental falls, aged, elderly, incidence, risk factors and morbidity. Abstracts of potentially relevant studies were assessed against the inclusion criteria. The search yielded 606 English language references; 29 potentially met the inclusion criteria.

One investigator (S.N.) appraised these 29 papers using quality criteria proposed by Stalenhoef *et al.*[5] (Table 1). Uncertainty about the application of one or more criteria in one-third of these papers was resolved by discussion with a second investigator (G.F.). Five studies[11–15] met seven or more criteria, as did the four studies previously identified by Stalenhoef *et al.*[5]

We grouped into six categories the risk factors identified in all nine high quality prospective studies published between 1981 and 2000: demographic, physical functioning related to legs/strength/balance and gait, physical functioning related to other measures, medication, mental functioning, history and co-morbidity. The different studies measured different risk factors, different combinations of risk factors and were different sizes. In order to quantitatively identify the factors that were likely to be most highly associated with falls we ranked risk factors within each category in two ways, first, according to the odds ratio, and secondly, by the value of the lower limit of the 95 per cent confidence interval (CI). These two rankings were then averaged to obtain a composite ranking within a category.

Table 1 Criteria for assessing methodological quality of cohort studies of risk factors for falls among older people, after Stalenhof *et al.*[5]

A clear definition of falling had been given
An adequate sample size had been chosen (minimum 100) and sampling procedures had been carried out and described in a proper manner
The outcomes were applicable to the elderly population in general practice
The design was prospective rather than retrospective
An adequate assessment had been made with the usual techniques, e.g. questionnaires, interviews and/or clinical examinations during home visits with standardized procedures and measurements
The duration of follow-up was at least 6 months
The loss during follow-up had been <20%
The data analysis, data interpretation and data presentation were appropriate, i.e. (i) all relevant outcomes were reported, (ii) the outcome parameters were presented in an appropriate way and (iii) the data were analysed using methods for multivariate analysis
The study could be reproduced by other investigators on the basis of description of methods and outcomes

We convened a panel consisting of three general practitioners (Y.C., G.F., S.N.) and a statistician with expertise in the subject (C.C.), to choose, through informal consensus, the risk factors for inclusion in part 1 of the tool. As well as considering the rank of each item, the panel discussed overlap with other items and the feasibility of measurement in a primary or social care setting by someone without clinical training. For part 2 of the tool the panel worked with an exercise physiologist specializing in falls (D.S.) and also considered the results of two randomized controlled trials of multi-faceted interventions for falls prevention[16,17] which had undergone further analysis.[18,19] A second panel meeting was held after extensive piloting of the draft risk assessment tool by health and social care workers to take into account their views about practical aspects of individual items, focusing particularly on the comprehensibility and feasibility of the guidance.

The Falls Risk Assessment Tool (FRAT) was piloted amongst primary healthcare workers, social care workers (including social workers and a home from hospital team), physiotherapists, occupational therapists and residential home carers. Training sessions were held prior to piloting and all participating professionals were asked to comment on the tool and on the feasibility of the suggested referral pathways. We obtained further comments from staff after they had used the draft tool with several patients or residents.

Examination of predictive validity of part 1

To examine the predictive validity of the FRAT we included the items in part 1 in a postal questionnaire survey to a random sample of 1000 people aged over 65 years living in one Primary Care Group area. Ethical approval for the study was obtained from Barking and Havering Local Research Ethics Committee. A second questionnaire, with up to two reminders was sent 6 months later to all those who had responded to the baseline questionnaire. Each questionnaire included questions incorporating the five items in part 1, some demographic questions and the Euroqual quality of life measure. Respondents were also asked if they had 'fallen in the last 6 months'. With an endpoint of one or more falls during the 6 month period, we calculated the sensitivity, specificity and positive and negative predictive values of part 1 over a 6 month period. We used Youden's index[20] [(sensitivity + specificity) – 1] for rating diagnostic tests to inform final recommendations for screening cut-off points.

Results

Risk factors

We identified nine high quality prospective cohort studies with falls, recurrent falls or injurious falls as their outcome. The

significant risk factors after multivariable analysis (e.g. logistic regression) for each of the included studies are listed in Table 2. The risk factors were ranked (see Methods) within six broad categories (details available from the author). The final items included in part 1 of the FRAT were: history of falling in the previous year, taking four or more prescribed medications, history of stroke or Parkinson's disease, reported problems with balance and loss of proximal muscle strength (Table 4). History of falling is simple to ascertain and a significant predictor of future falls. Use of four or more medications was associated with a high relative risk of falling in one study. History of stroke or Parkinson's disease was included as an item because each is a strong independent predictor of falls. The question 'are there any problems with balance?' and asking the person being assessed to rise from a chair of knee height without using their arms (used in two of the studies), covered most of the other significant items in the physical functioning category.

Factors that were also identified from the nine prospective cohort studies, but which were subsequently dropped or modified after review were: lower extremity disability (any reported problems with strength, sensation or balance), use of sedatives, history of arthritis and cognitive impairment. The main criteria for exclusion were overlap between risk factors and limited evidence (i.e. significant risk factor in only one study) (details available from the authors).

Part 2 of the FRAT includes guidance on further referral and interventions for those with the following risk factors: (i) history of falling in the previous year, (ii) taking four or more medications per day, (iii) balance and gait problems, (iv) postural hypotension. These were supported by trials of multi-faceted intervention.[16–19] Additional risk factors that were part of the original candidate list of factors for part 2, but subsequently dropped on review were: diagnosis of stroke, diagnosis of Parkinson's disease, poor visual acuity and peripheral neuropathy. The first two were removed because, although they contribute to risk, they are largely addressed by assessing balance and gait; assessment of vision was removed since associations between poor vision and falls in the cohort studies were weak; peripheral neuropathy was removed because, in the pilot study, nurses were not confident about testing sensation.

The first two items in part 2 are the same as in part 1, although in part 2 further methods of assessment are recommended for both items. Balance and gait assessment is covered in greater depth. Asking an older person to talk while they walk is a sensitive predictor of future falls in the hospital setting[21] and is currently under investigation in ambulatory care. The assessments of balance and gait were altered after comments from district nurses who tried to use the draft tool. The 'timed up and go' test was originally included because of the association of slower times with poor balance,[22] but then removed because of difficulties implementing the test within the confines of patients' homes. It was replaced by the 'one-leg stand' test, which is moderately good at predicting falls.[23] Testing for postural hypotension was feasible for part 2 as assessment is by a doctor or nurse. Guidance on the use of hip protectors in frail ambulatory older people was included in part 2 because of evidence that risk of hip fracture can be reduced by the use of an external hip protector.[24] Parts 1 and 2 of the FRAT are presented in the Appendix.

Examination of the positive predictive value of part 1

A total of 510 people (51 per cent) responded to the baseline survey. Of these, 345 (67.6 per cent) responded to the second survey 6 months later. The characteristics of these respondents are shown in Table 3. The tool's ability at baseline to predict falls within the following 6 months which were reported by the respondents in the 6 month questionnaire is summarized in Table 4. The sensitivity ranged from 0.59 (95 per cent CI 0.48–0.70) to 0.15 (0.09–0.26) and the specificity ranged from 0.80 (0.74–0.84) to 0.97 (0.94–0.99), respectively, depending on whether two, three or four or more risk factors were used as the cut-off for increased risk. Youden's index was similar for two and three risk factors (0.39 and 0.34, respectively), but much lower for four or more risk factors (0.13) (Table 4).

Discussion

The UK National Service Framework for Older People[25] recommends identification of those most at risk of falls to prioritize further management. We have developed a pragmatic falls risk assessment tool that can be used by a wide range of care professionals to identify a group of older people in primary and residential care at high risk of falling.

The presence of three or more of these risk factors may be the most appropriate cut-off point for this screening tool. It has a high specificity (0.92, 95 per cent CI 0.88–0.94) and a positive predictive value of 0.57 (0.43–0.69). That is, over half of those identified as high risk fell during the subsequent 6 months. The positive predictive value is acceptable as the consequences of intervention for those identified as high risk who will not fall in the next 6 months are likely to be beneficial in other ways, although health service resources would be consumed in further assessment. The low sensitivity (0.42, 95 per cent CI 0.32–0.54) and negative predictive value (0.86, 0.83–0.89) means that a negative screen does not exclude risk of falling; 14 per cent of those who were screen negative reported falls compared with 57 per cent who were screen positive.

This preliminary estimation of predictive validity has several limitations. First, part 1 is designed for direct administration by clinicians or social care staff, whereas the validation used data from self-completed postal questionnaires. This is likely to have led to some error in the reporting of the absence or presence of risk factors. Secondly, the high proportion of respondents living alone who own their own homes and the lack of ethnic minorities means this sample is not representative of older people throughout the United Kingdom. Thirdly, recall does not necessarily measure the true occurrence of falls.[26] However, in our survey, 6 month recall of falls was comparable with diary card

Table 2 Statistically significant risk factors in the nine included studies

Study	Risk factors identified		Odds ratio	95% CI
Tinetti *et al.*[7]	Use of sedatives (benzodiazepines, phenothiazines or antidepressants)		28.3	3.4–239.4
	Cognitive impairment (at least 5 errors on 'short portable mental status questionnaire)		5.0	1.8–13.7
	Lower extremity disability (any reported problems with strength, sensation or balance)		3.8	2.2–6.7
	Palmomental reflex		3.0	1.5–6.1
	Foot problems (moderate or severe bunions, toe deformities, ulcers or deformed nails)		1.8	1.0–3.1
	More than six balance and gait abnormalities (of unsteady sitting down, unable to stand on one leg unsupported, unsteady turning, unsteady after gentle push on sternum, increased trunk sway, unable to pick up walking pace, increased path deviation)		1.49	1.0–3.7
Nevitt *et al*[8]	History of ≥3 falls in previous year		2.4	1.3–4.4
	White race (compared with 'other' – black, Hispanic, Asian, Pacific Islander)		2.4	1.1–5.3
	History of previous fall with injury		3.1	1.5–6.6
	History of arthritis		2.7	1.3–5.6
	Diagnosis of Parkinson's disease		9.5	1.8–50.1
	Difficulty standing up from chair (unable or ≥2.0 s to stand up)		3.0	1.2–7.2
	Poor tandem gait (asked to perform tandem walk along a 2 m line, 5 cm wide; poor = unable to or ≥8 errors)		2.7	1.1–6.2
Campbell *et al.*[9]	Loss of proximal muscle strength (measured by inability to rise from chair of knee height without using arms)	M	3.4	1.4–8.4
	Use of 1–3 drugs	W	2.6	1.2–5.5
	Use of 4+ drugs	M	4.5	1.9–10.6
	Use of psychotropic drugs	W	1.6	1.0–2.8
	Signs of knee arthritis (examined by a physician)	M	2.7	1.3–5.3
		W	1.8	1.1–2.8
	History of stroke	W	13.6	2.6–71.3
	Body sway (assessed using a Wright Codoc ataxiameter, >60° in 1 min)	M	2.6	1.3–5.1
		W	1.7	1.0–2.9
	Older age			
O'Loughlin *et al.*[10]	Dizziness (in the 14 days preceding the interview)	F	2.0	1.3–2.8
	Frequent physical activity (engagement ≥10 times during previous week in a physical activity from a list of common activities, e.g. dancing, gardening)	F	2.0	1.3–3.0
		IF	2.1	1.1–3.8
	Days of limited activity (cutting back on activities normally undertaken because of a health problem in the 14 days preceding the interview)	F	1.8	1.3–2.6
		IF	2.2	1.4–3.6
	History of stroke	IF	2.4	1.3–4.5
	History of respiratory disorder (asthma, emphysema or chronic bronchitis)	IF	1.7	1.1–2.8
	Trouble walking 400m (without resting)	F	1.6	1.2–2.4
	Trouble bending down (to pick up an object from the floor)	F	1.0	1.0–2.0
Tinetti *et al.*[11]	Cognitive impairment (Folstein MMS examination <26)		2.2	1.5–3.2
	At least two chronic conditions (out of: MI, stroke, cancer, DM, arthritis, Parkinson's syndrome)		2.0	1.4–2.9
	Balance and gait impairment (balance and gait scores calculated using tests of balance manoeuvres and gait manoeuvres, <12/22 considered impaired)		1.8	1.3–2.7
	Low BMI (<22)		1.8	1.2–2.5
Luukinen *et al.*[12]	History of falling (during the previous year)		3.3	2.0–5.4
	Peripheral neuropathy (vibration sense absent and pain sense on knees reduced)		1.9	1.1–3.2
	Use of psychotropic medication		2.1	1.3–3.4
	Slow walking speed (<0.77 m/s over 10 m)		1.8	1.1–3.0
Graafmans *et al.*[13]	Mobility impairment (impairment of balance, leg-extension strength or gait)	F	2.6	1.6–3.4
		RF	5.0	2.2–11.4
	History of dizziness upon standing	F	2.1	1.2–3.7
		RF	2.1	1.1–4.2
	History of stroke	RF	3.4	1.5–7.9
	Poor mental state (MMSE 24 or less)	RF	2.4	1.2–4.8
	Orthostatic (postural) hypotension (a drop of ≥20 mmHg in systolic BP and/or ≥10 mmHg in diastolic)	RF	2.0	1.0–4.2
Northridge *et al.*[14]	Parkinson's disease		7.7	1.2–51.1
	Arthritis			
	Environmental (related to home hazards) first fall		2.6	1.3–5.1
	Non-environmental second fall		2.7	1.1–6.5
	Environmental second fall		2.9	1.2–7.0
Koski *et al.*[15]	Peripheral neuropathy (decreased pain sense in feet)		2.5	1.1–5.7
	Insomnia		4.1	1.7–9.8

F, fall; RR, relative risk; IF, injurious fall; RF, recurrent falls; M, in men; W, in women.

recording.[4] Full validation requires a prospective study where the tool is administered to older people in the same contexts in which it will be used in practice.

Limitations of cohort studies used to identify predictive factors

The main source of evidence for our choice of risk factors in our tool was cohort studies and these have limitations when used to develop a falls risk assessment tool. These studies have heterogeneous population bases, a variety of outcomes (falls, recurrent falls, injurious falls) and included different risk factors. Even when risk factors were ostensibly the same between studies, they were often assessed using different methods, which partly accounts for the inconsistency in results between some of the studies. In addition, none of the studies reported multivariable analyses using all the factors we finally chose for the assessment tool, so we are not certain that our tool contains the most efficient combination of factors. In eight of the nine prospective cohort studies identified in our review, the participants lived at home. Consequently, use of the tool in residential care populations is less justified.

Table 3 Baseline characteristics of responders to questionnaire survey used to validate the FRAT

Characteristic	Proportion (number/total responses)
Female (%)	55 (189/343)
Mean age (standard deviation) (years)	74.4 (6.4)
Age range (years)	65–92
Living alone (%)	32 (109/340)
People living alone who are home owners (%)	83.2 (90/108)
White (%)	98.8 (334/338)
Left full time education at 16 years or younger (%)	87.0 (290/333)
Access to car transport (%)	63.8 (217/340)
% With balance problems	24.8 (85/342)
% Fallen in the past 6 months	25.3 (86/339)
% With >1 fall in the past 6 months	34.9 (30/86)
Received medical attention for fall	
% Seen in accident and emergency department	17.4 (15/86)
% Visited general practitioner	18.6 (16/86)
% Afraid of falling if have fallen	52.0 (44/85)
% Afraid of falling if have not fallen	21.9 (53/242)
% Reporting mobility problems	36.2 (119/328)
Euroqol mean score (standard deviation)	0.76 (0.26)

The wider trial literature as systematically reviewed in guidelines[1,2] supports our choice of factors for part 2 of the tool:

- Falls history: trials of exercise targeting older people with a history of falls resulted in reduced rates of falling.
- Medicine review: reduction in total number of medications or in prescribing of psychotropic drugs is an important component of multi-faceted interventions in positive falls prevention trials.
- Balance and gait problems: trials targeting older people with these and other mobility problems that offered individualized exercise programmes showed a reduction in falls.
- Postural hypotension: management of postural hypotension was part of an effective intervention in two trials.

We believe that following further evaluation, the FRAT may prove useful in the single assessment of older people, as recommended in the National Service Framework for Older People.[25] Recent Department of Health guidance gives examples of assessment tools and scales.[27] Three of the recommended tools, Camberwell Assessment for the Needs of the Elderly (CANE), EASY-Care 2002–2005, Functional Assessment Care Environment (FACE), only elicit a falls history or a clinical judgement of falls risk without guidance on further assessment or management for people at risk of falling. The fourth (MDS-Home Care) uses a range of risk factors in the initial screen and recommends detailed specialist assessment if any are present.

Impaired vision has traditionally been considered an important risk factor for falls in older people, but our review did not find strong evidence that visual impairment was independently associated with falling. A more recent review,[28] with a wider search strategy, found 20 studies that satisfied their selection criteria. The review found that older people with decreased visual acuity and other visual deficits are more likely to have a fall compared with fully sighted populations and more likely to have recurrent and injurious falls. No single intervention studies were identified that developed and evaluated vision-related interventions to reduce the risk of falls or falls injuries, and the effects of vision testing and appropriate referral/treatment in multifactorial interventions could not be isolated. On the basis of this evidence, visual impairment could be included in an assessment tool, probably in the equivalent of our part 2.

In summary, our tool is designed for use by clinical and non-clinical care professionals and is particularly suited to primary

Table 4 Sensitivity, specificity and predictive values of the FRAT

Threshold for high risk	Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)	Youden's index (95% CI)
Two or more risk factors	0.59 (0.48–0.70)	0.80 (0.74–0.84)	0.43 (0.34–0.53)	0.88 (0.84–0.92)	0.387 (0.263–0.511)
Three or more risk factors	0.42 (0.32–0.54)	0.92 (0.88–0.94)	0.57 (0.43–0.69)	0.86 (0.83–0.89)	0.339 (0.185–0.493)
Four or more risk factors	0.15 (0.089–0.26)	0.97 (0.94–0.99)	0.58 (0.37–0.77)	0.82 (0.77–0.86)	0.126 (0.040–0.212)

care. Based on longitudinal studies of falls risk, we prioritized risk factors that can be quickly assessed. Social care workers, primary care professionals, occupational therapists and physiotherapists who piloted the tool found it easy to use routinely. Part 1 of the tool takes at most a few minutes to administer and can be incorporated into other assessments such as primary care health checks or residential home admission assessments, and used opportunistically during a general practice consultation. Preliminary validation suggests the tool has an acceptable positive predictive value and this pragmatic, simple tool may help to identify patients who would benefit from further investigation and intervention.

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